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Automatic imitation effects are influenced by experience of synchronous action in children

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ABSTRACT

By their fourth year of life, children are expert imitators, but it is unclear how this ability develops. One approach suggests that certain types of experience might forge associations between the sensory and motor representations of an action that may facilitate imitation at a later time. Sensorimotor experience of this sort may occur when an infant's action is imitated by a caregiver or when socially synchronous action occurs. This learning approach, therefore, predicts that the strength of sensory–motor associations should depend on the frequency and quality of previous experience. Here, we tested this prediction by examining automatic imitation, that is, the tendency of an action stimulus to facilitate the performance of that action and interfere with the performance of an incompatible action. We required children (aged between 3 years 8 months and 7 years 11 months) to respond to actions performed by an experimenter (e.g., two hands clapping) with both compatible actions (i.e., two hands clapping) and incompatible actions (i.e., two hands waving) at different stages in the experimental procedure. As predicted by a learning account, actions thought to be performed in synchrony (i.e., clapping/waving) produced stronger automatic imitation effects when compared with actions where previous sensorimotor experience is likely to be more limited (e.g., pointing/hand closing). Furthermore, these automatic imitation effects were not found to vary with age, with

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both compatible and incompatible responses quickening with age. These findings suggest a role for sensorimotor experience in the development of imitative ability.

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Introduction

Copying the behavioral morphology of an action is often considered to be cognitively demanding due to the correspondence problem (i.e., the sensory mismatch when observing one's own actions and those of another; Nehaniv & Dautenhahn, 2002), and imitating actions that in some cases are unobservable to the imitator (also known as opaque actions; e.g., facial expressions) requires a mechanism for transforming sensory information into a corresponding matching action. It has been suggested that humans are born with an intermodal representation space where proprioceptive feedback from an action can be compared to a sensory representation of the same action, facilitating action imitation (the active intermodal mapping hypothesis; Meltzoff & Moore, 1997). On the other hand, domain-general accounts propose that associative learning links sensory and motor representations to overcome the correspondence problem, for example, the associative sequence learning (ASL) approach and the ideomotor approach (Brass & Heyes, 2005; Heyes & Ray, 2000). However, although experience-dependent approaches have been extensively studied in adults, few studies have tested their predictions in children.

There is no consensus in the field of developmental psychology about when infants first exhibit a capacity for imitation. However, researchers predominantly fall into one of two camps. Some believe that an imitative faculty is present from birth (Meltzoff & Moore, 1997; Nagy et al., 2005; Simpson, Murray, Paukner, & Ferrari, 2014), whereas others believe that imitative ability develops throughout the first years of life (Jones, 2009; Ray & Heyes, 2011). The observation that infants imitate facial gestures within hours of being born was first reported by Meltzoff and Moore (1977), and there have been many attempts to replicate these findings, with mixed results. Some studies report evidence of a number of actions being imitated from birth, including tongue protrusion, mouth opening, finger movement, and emotional expressions (Field, Woodson, Greenberg, & Cohen, 1982; Meltzoff & Moore, 1977, 1983; Nagy, Pilling, Orvos, & Molnar, 2013; Nagy et al., 2005), whereas others find either selective imitation of only certain actions or no imitation at all (Anisfeld et al., 2001; Hayes & Watson, 1981; Heimann, Nelson, & Schaller, 1989; Oostenbroek et al., 2016). Studies of nonhuman primates have identified further evidence of neonatal imitation of mouth opening and tongue protrusion in chimpanzees (*Pan troglodytes;* Bard, 2007; Myowa-Yamakoshi, Tomonaga, Tanaka, & Matsuzawa, 2004), and evidence of lip smacking and tongue protrusion imitation in 3-day-old rhesus macaques (*Macaca mulatta;* Ferrari et al., 2006); however, note that there was no evidence of neonatal imitation of these actions when infants were 1, 7, or 14 days old, and no evidence of mouth opening or hand opening imitation was found. This evidence from nonhuman primates lends some weight to the notion of an evolved and innate action matching system that is at least sensitive to certain actions.

These empirical findings are granted different weight in reviews of the evidence, with both early reviews (Anisfeld, 1996; Meltzoff, 1996) and contemporary reviews (Lodder et al., 2014; Ray & Heyes, 2011; Simpson et al., 2014) often drawing conflicting conclusions about the presence of an innate imitative ability. Although a consensus answer to the neonatal imitation question is not forthcoming, some have suggested that overconfidence in neonatal imitation may distract from the empirical study of how imitative ability develops throughout infancy (Jones, 2007). Indeed, regardless of the presence or absence of innate imitative ability, it is important to consider both predispositions to imitation and the influence of ontogenetic processes.

An ability to imitate at birth does not preclude the involvement of learning processes later in development. In fact, some argue that evidence of imitative ability diminishing over the first few months (Ferrari et al., 2006; Fontaine, 1984) suggests that neonatal imitation may be a specific adaptation

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